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Medical audit

Shielding reproductive organs of orthopaedic patients during pelvic radiography

AM Wainwright

Oxford Deanery Regional Training Programme, UK

The use of gonadal shielding has been advocated for patients undergoing pelvic radiography before and during the reproductive years. The aim of this study is to look at the adequacy of gonadal shielding used in a district general hospital for young patients having pelvic radiographs. A total of 200 radiographs were reviewed of 49 patients below the age of 45 years. Full coverage was achieved in only 36% of cases. Amongst females, only 22% received adequate shielding. None of the patients in their reproductive years (16–45 years) had gonad shields. The reasons for inadequate coverage were, in order of frequency: (i) no shielding was used; (ii) malposition of the shielding device; and (iii) the use of inappropriately shaped or sized devices. Suggestions for improvement are proposed.

Key words: Young orthopaedic patients – Radiation – Pelvic radiography – Gonadal shielding

Almost a million pelvic radiographs are taken in Britain per annum,[1] with, potentially, a high dose of radiation exposure to the reproductive organs. Use of gonadal shielding has been advocated during pelvic radiography for patients at and below the reproductive age by the National Radiation Protection Board.[2]

The effects of radiation are often not seen for many years, or even the next generation, and it may be easy to become complacent about using radiation protection. The aim of this study is to look at the adequacy of gonadal shielding used for young patients who have had pelvic radiographs in a district general hospital in the Oxford region.

Patients and methods

Pelvic radiographs taken between April 1996 and April 1997 of patients of 45 years and below were reviewed, with their previous radiographs, to assess the adequacy of gonadal shielding. This age limit of 45 years was taken, as it is the commonly used upper limit of reproductive age, although it is accepted that conception is possible beyond this age. The hospital is a typical district general hospital within the Oxford region.

The hospital policy is that the first pelvic radiograph of a patient is taken without any shielding and, accordingly, this study only included subsequent

Correspondence to: Mr AM Wainwright, Specialist Registrar, Nuffield Orthopaedic Centre, Windmill Road, Headington, Oxford OX3 7LD, UK. Tel: +44 1865 741155; Fax: +44 1865 742348

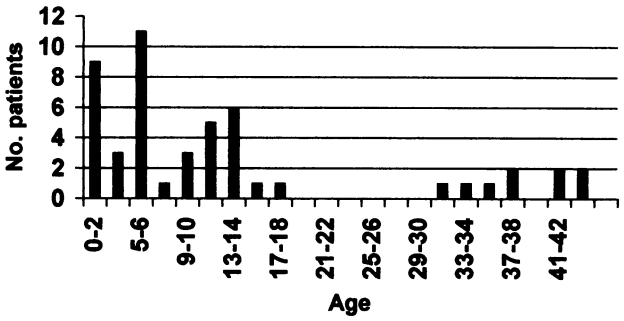

Figure 1 Number of patients by age group

radiographs. Shielding is also not used in pelvic radiographs taken as part of the initial assessment of patients attending with major trauma. Three patients had been discharged from follow-up and had been given their radiographs to keep; these were not available for review.

There were 200 radiographs examined of 49 patients. The age range of patients at the time of X-ray was between 6 months and 43 years (Fig. 1). Eighty-five radiographs were taken of 19 females, and 115 radiographs were taken of 30 males. The number of radiographs taken per individual was 2–17.

These radiographs were reviewed by one individual, using a standard proforma. Indications for pelvic X-ray (Fig. 2) were to investigate developmental dysplasia of the hip (DDH) in 63 films (32%), Perthe's disease, 57 films (29%), and slipped upper femoral epiphyses (SUFE) in 52 films (26%). Other indications were 'hip pain', 10 films (5%), osteo-arthrosis (OA), 10 films (5%) and various reasons, 8 films (4%).

Criteria that were used in this proforma were: (i) whether any shielding was visible on the pelvic radiograph; (ii) whether the area obscured by shielding covered the projected area of the gonads – in males, this was taken as the soft tissue outline of the scrotal sac, in females, an area just medial to the ischial spines; and (iii) when shielding was present, but inadequate because of malposition, was there a consistent direction.

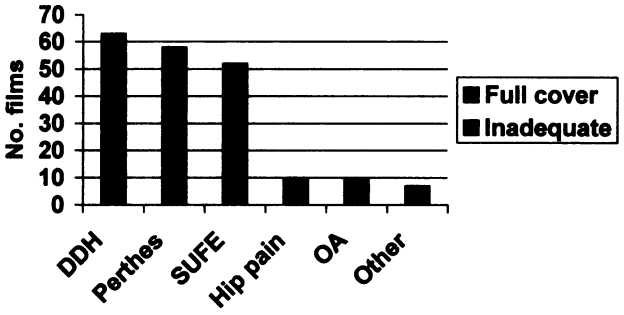

Figure 2 Number of X-ray films by indication, showing number of radiographs with adequate protective cover

Results

Full coverage was obtained in only 72 radiographs (36%), partial coverage was achieved in 44 (22%), and the gonads were left completely exposed in 84 cases (42%).

Reason for deficiency

The reason for deficiency was investigated for subgroups divided by age and sex (Table 1). Of the whole group, there were 128 radiographs (64%) where shielding was partially or totally inadequate. No shielding had been used for 68 cases (34% of the total), the shielding was mal-positioned in 44 cases (22%), and the shielding was not large enough in 16 cases (8%).

Gender

Of the male subgroup, 53 (46% of male pelvic radiographs) had satisfactory cover, 29 (25%) had no shield, 23 (20%) mal-positioned shield (Fig. 3), and 10 (9%) had inadequately sized shields.

Table 1 Shielding on pelvic radiographs

	Satisfactory	None used	Malposition	Wrong size
Male	53	29	23	10
Female	19	39	21	6
0–16 years	72	49	44	16
16–45 years	0	19	0	0
Total (n = 200)	72	68	44	16

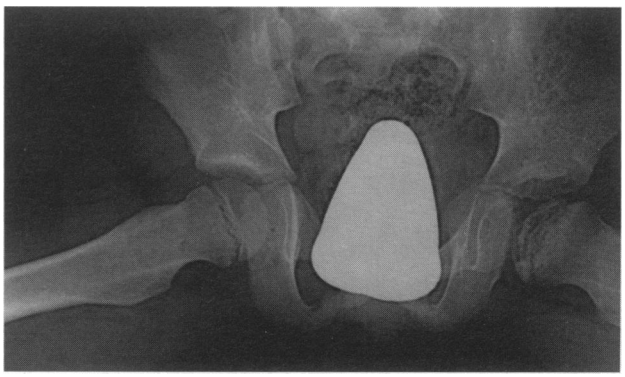

Figure 3 Example of mal-positioned shield

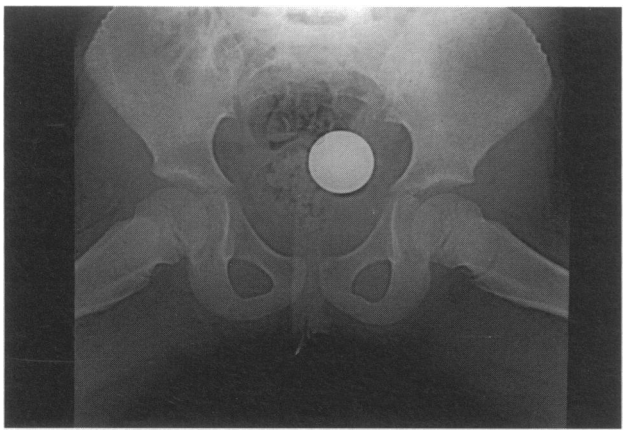

Figure 4 Example of inappropriate shield

Where females had been X-rayed, only 19 (22% of female pelvic radiographs) had satisfactory cover. This was mainly because 39 (46%) radiographs were taken without any shielding. This was a significant difference between sexes ($P < 0.05$, Chi squared test). In 21 cases (25%), the shield was mal-positioned and in 6 cases (7%) the shield was too small (Fig. 4).

Malposition

For those patients where the shielding was mal-positioned, the direction was classified as being too superior, inferior, too far to the left or right. There was no consistent direction demonstrated for either sex.

Age

In those patients over the age of 16 years, there were 19 radiographs taken; none had any shielding devices.

Discussion

The results of the study in a district general hospital in the Oxford region have shown that only a minority of patients had adequate shielding during pelvic radiography. No patients in their reproductive years (16–45 years) had any gonadal shielding on their pelvic radiographs. Overall, nearly two-thirds of pelvic radiographs taken of patients at or before their reproductive years had inadequate shielding. Over three-quarters of pelvic radiographs of females had inadequate or no shielding of the ovaries.

The most frequent reason for the deficiency was that no shielding device was provided (a third of cases), and for all patients over the age of 16 years. This was a particularly common reason in nearly half (46%) of radiographs of females. This may be because the accurate placement of pelvic shielding is more difficult in females, and shields were omitted rather than used risking coverage of important anatomical detail. Where shielding had been used, deficiencies were caused by malposition of the shielding device, and the use of inappropriate shields.

This hospital is probably typical of many hospitals and it is likely that a similar level of deficiency of shielding would be seen in other units in the UK. This supposition is confirmed by two other articles that showed 45% and 71% inadequacy of gonadal shielding.[3,4] A report by the Consumer Association in *Which?* magazine[5] brought to the public attention that unnecessary radiation might be responsible for 100–250 cancer deaths per year. This was based on data provided by the National Radiation Protection Board and Royal College of Radiologists. A survey in the same article reviewed a nationally representative sample of 2229 adults, and found that 502 of them had had radiographs taken at a hospital. On questioning, 42% of men and 66% of women said that no gonadal shielding had been used where radiologists would consider shielding to be desirable and practical. Despite the problem being highlighted in the literature, it remains.

The typical life-time risk of fatal cancer following a pelvic X-ray examination has been estimated to be 15–55 per million. This is the life-time risk averaged for all age groups and both sexes. Younger people have a longer life expectancy, and this increases the opportunity for expression of delayed radiation effects. The most pessimistic assumptions of the risks of fatal cancer for those exposed in childhood could be twice this upper estimate (*i.e.* 110 per million).[2] In addition, young patients have a higher rate of cell turnover and many undergo intensive periods of radiological examinations. The risk of inducing fatal cancer during the course of a long-standing condition in a young patient may well accumulate to a level of one in a few hundred.[2]

The probability of non-fatal cancers arising from radiation exposure has been estimated at 50% of the risk of fatal cancers. The risk is not just to the somatic cells, but also to the germ cells. The effects of irradiating an individual's gonads will not be seen in the short-term, and perhaps until the next generation when there is a risk of inducing severe hereditary disease. This risk has been estimated at 2% per Gray to the gonads of either parent, if effects to all subsequent generations are considered.[6] The probability of radiation from a pelvic X-ray examination causing a hereditary effect has been estimated at 24 per million with paternal irradiation and 6.3 per million with maternal irradiation.[2] A study in

Cumbria showed an excess risk of leukaemia and non-Hodgkin's lymphoma in children of fathers with a high radiation dose recorded prior to conception.[7]

The number of pelvic radiographs taken in NHS hospitals in 1983 was 979,900,[1] which had increased by 6% compared with six years previously. A recent study[4] of pelvic radiation found that a standard radiograph at 70 kVp and 16 mAs gave an estimated dose of 0.83 micro Sieverts per testis per film and 0.21 micro Sieverts per ovary per film. Using lead shielding reduced this to 0.06 and 0.03 micro Sieverts, respectively.

The use of gonad shields has been advocated for those radiological investigations where the gonads lie within or close to the primary beam. These are contained in national guidelines published within the *Ionising Radiation Regulation* (1985), *The Approved Code of Practice* and within many National Radiation Protection Board reports.

This study did not attempt to assess the number of radiographs where shielding obscured important anatomical detail. This would be best performed prospectively by the clinician stating whether the shielding covered an area that was required for management decision making. In addition, there was no record of the number of films taken but rejected by the radiographer and repeated because relevant anatomy was obscured.

Several problems are often encountered by radiographers taking pelvic radiographs. Young children are often frightened of the environment and may move the shield if they wriggle. Young males may be self-conscious about having shielding placed. Useful advice regarding these problems was presented in an article which described how shielding should be shaped and placed.[8] This included a method for moving the waistband of boys' underclothes to the level of the symphysis pubis, supporting the shield on the waistband and thighs. There is no similar advice for females, but it would appear that such suggestions are particularly needed for females.

The following proposals for improvement are suggested.

1. General improvement in the level of awareness regarding risks of radiation.
2. Reminders to use gonad shielding should be placed in areas where the radiographs are taken, particularly amongst patients over the age of 16 years, but less than 45 years, and for females.
3. The requester should write on the request card a reminder to use shielding.
4. The requester should write on the request card the reason that shielding is to be omitted, if patients are below 45 years old.
5. Current shield devices that are used should be re-evaluated, to see whether improvements can be made to increase shielding, whilst not obscuring areas relevant to the investigation.

The overall potential effect of medical X-rays is a benefit to the health of patients, which justifies their use. However, all of those who request radiographs are responsible to ensure that the minimum amount of radiation exposure is used. This includes not only using radiological protection as effectively as possible, but also reducing the number of unnecessary radiological investigations requested.

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